Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2801

February 18, 2000

Mr. William Grimley
Emissions Measurement Center
United States Environmental
Protection Agency
Interstate 40 and Page Road
4930 Old Page Road
Room Number E-108
Durham, North Carolina 27709

Dear Mr. Grimley:

TENNESSEE VALLEY AUTHORITY (TVA) - SUBMITTAL OF MERCURY STACK SPECIATION TEST REPORTS FOR SHAWNEE AND WIDOWS CREEK FOSSIL PLANTS

Enclosed are three copies of the mercury speciation test reports for TVA's Shawnee (SHF) and Widows Creek (WCF) Fossil Plants. This information is being submitted as required by Part III of the U.S. Environmental Protection Agency (EPA) Mercury Information Collection Request (ICR), approved on November 13, 1998 by the Office of Management and Budget. The testing was conducted at SHF Unit 3 on October 27, 28, and 29 and at WCF Unit 6 on October 19, 20, and 21, 1999.

Part III of the ICR requires submittal of this information within 90 days after completion of the testing. TVA notified EPA in a letter dated January 7, 2000 that submittal would be delayed until February 18, 2000 due to the time required for the contractor who performed the testing to develop the test reports.

If you need any additional information, please call Cynthia Wren at (423) 751-7561.

John W Myers for

Janet K. Watts
Manager of Environmental Affairs
5D Lookout Place

Enclosures
cc (Enclosures):

Mr. William H. Maxwell (w/o Enclosures)
Combustion Group (MD-13)
United State Environmental
Protection Agency
Research Triangle Park, North Carolina 27711

Mr. Roger Cook (w/ copy of SHF report)
Division for Air Quality
Kentucky Department for Natural Resources
and Environmental Protection
803 Schenkel Lane
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SOURCE EMISSIONS SURVEY
OF
TENNESSEE VALLEY AUTHORITY
WIDOWS CREEK FOSSIL PLANT
UNIT NUMBER 6 PRECIPITATOR INLET DUCTS
AND OUTLET DUCTS
STEVENSON, ALABAMA
FOR
ELECTRIC POWER RESEARCH INSTITUTE

OCTOBER 1999

FILE NUMBER 99-95WCR6

METCO ENVIRONMENTAL

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1 INTRODUCTION

1.1 Summary of Test Program

The report summarizes the mercury speciation characterization study conducted at the Tennessee Valley Authority (TVA), Widows Creek Fossil Plant (WCF), located at County Road 96, Stevenson, Alabama. The purpose of the study was to meet the requirements of Part III of the U.S. Environmental Protection Agency (EPA) Mercury Information Collection Request (ICR) approved on November 13, 1998 by the Office of Management and Budget. The Mercury ICR was issued by the EPA under authority of section 114 of the Clean Air Act (42 U.S.C. 7414).

As provided in Part III of the ICR, affected units were grouped into categories based on the type of emission control equipment installed and type of coal burned. TVA's WCF was randomly selected from one of EPA's categories for this testing. The testing was performed by METCO Environmental, Dallas Texas for the Electric Power Research Institute (EPRI), and TVA, on October 19, 20, and 21, 1999. The testing was conducted at WCF Unit Number 6 and consisted of simultaneous measurements of speciated mercury concentrations at the Precipitator A Inlet and Outlet Ducts. In addition, concurrent flow rate measurements at the Precipitator B Inlet and Outlet Ducts was performed and concurrent coal sampling was done to determine the mercury, chlorine, sulfur, ash and Btu content.

The sampling followed the procedures set forth in the Code of Federal Regulations, Title 40, Chapter I, Part 60, Appendix A, Methods 1, 2, 3B, 4, 5, 17, and 19; in the "Standard Test Method for Elemental, Oxidized, Particle-bound, and Total Mercury in Flue Gas Generated from Coal-Fired Stationary Sources (Ontario Hydro Method), Revised July 7, 1999; and ASTM Methods D2234, D6414-99, D2361-95, D-0516, D-3174, and D-3286.

1.2 Key personnel

The Table 1-1 summarizes key test personnel and affiliation.

Mr. Bill Hefley of METCO Environmental was the onsite project manager. Mr. Steve Bornsen, Mr. Shane Lee, Mr. Mike Bass, Mr. Jason Conway, Mr. Scott Hart, and Mr. Jason Brown of METCO Environmental performed the testing.

Mr. John Myers of the Tennessee Valley Authority acted as the utility representative. Mr. Bill Oberg of the Tennessee Valley Authority performed process monitoring and sampling.

Mr. Paul Chu was the Electric Power Research Institute project manager.

Table 1-1
Test Program Organization

Organization	Individual	Responsibility	Phone Number
Project Team			
METCO	Bill Hefley	Project Manager	(972) 931-7127
Utility			
TVA	John Myers	Utility Representative	(423) 751-8855
TVA	Bill Oberg	Process Monitoring & Sampling	(423) 751-2766
QA/QC			
EPRI	Paul Chu	Project Manager	(650) 855-2812

2 SOURCE AND SAMPLING LOCATION DESCRIPTIONS

2.1 Process Description

WCF Unit Number 6 is a Babcock and Wilcox Company steam generator which began operating in 1954. The steam generator is a reheat unit of the single-pass, waterwall, radiant-boiler type with a divided, dry-bottom furnace with a nameplate generating capacity of 141 megawatts and a maximum heat input capacity of 1589 MMBtu/hr.

A single coal bunker, four (4) coal scales, and four (4) pulverizers provide coal to the unit. Coal flows by gravity from the coal bunker to the coal scales. The bunker has an exhaust fan and cyclone dust collector, which can be used to vent any combustible gases. The coal is fed into the pulverizers from the coal scales were the particle size is reduced to a fine dust. The pulverized coal is transported into the boiler by primary air fans for firing.

Bottom ash from the furnace section flows by jet pulsion pump to the active ash pond. The flue gas from the unit flows through an electrostatic precipitator, then an induced draft fan and into the atmosphere through a common stack for Unit 1-6. Fly ash collected by the electrostatic precipitators is sluiced by the wet ash handling system to the active ash pond. A Process Flow Diagram is provided as Figure 2-1.

2.2 Control Equipment Description

The air pollution control equipment consists of a Pollution Control Walther rigid frame cold side electrostatic precipitator. Unit Number 6 Precipitator was designed for 575,000 acfm at 355 °F with an efficiency of 99.60%. The precipitator has two sides, A and B, with each side consisting of five fields. Each field consists of 32 plates and 1 TR set for a total collection area of 322,560 ft^2.

2.3 Flue Gas and Process Sampling Locations

2.3.1 Inlet Sampling Locations

The sampling location on the Unit Number 6 Precipitator A Inlet Duct is 97 feet above the ground. The sampling location is located 8 feet 6 inches (1.06 equivalent duct diameters) downstream from a bend in the duct and 17 feet 7 inches (2.20 equivalent duct diameters) upstream from a bend in the duct. A diagram of the inlet sampling locations is provided in Figures 2-2 and 2-3.

The sampling location on the Unit Number 6 Precipitator B Inlet Duct is 97 feet above the ground. The sampling location is located 8 feet 6 inches (1.06 equivalent duct diameters) downstream from a bend in the duct and 17 feet 7 inches (2.20 equivalent duct diameters) upstream from a bend in the duct. A diagram of the inlet sampling locations is provided in Figures 2-4 and 2-5.

2.3.2 Outlet Sampling Locations

The sampling location on the Unit Number 6 Precipitator A Outlet Duct is 32 feet above the ground. The sampling locations are located 12 feet 7 inches (1.25 equivalent duct diameters) downstream from a bend in the duct and 5 feet 7 inches (0.55 equivalent duct diameters) upstream from a bend in the duct. A diagram of the outlet sampling locations is provided in Figures 2-6 and 2-7.

The sampling location on the Unit Number 6 Precipitator B Outlet Duct is 32 feet above the ground. The sampling locations are located 12 feet 7 inches (1.26 equivalent duct diameters) downstream from a bend in the duct and 5 feet 7 inches (0.56 equivalent duct diameters) upstream from a bend in the duct. A diagram of the outlet sampling locations is provided in Figures 2-8 and 2-9.

2.3.3 Coal Sampling Location

The coal sampling locations are located at the coal scales immediately downstream of the coal bunkers. A diagram of the coal sampling location is provided in Figure 2-10.

Figure 2-1
Process Flow Diagram

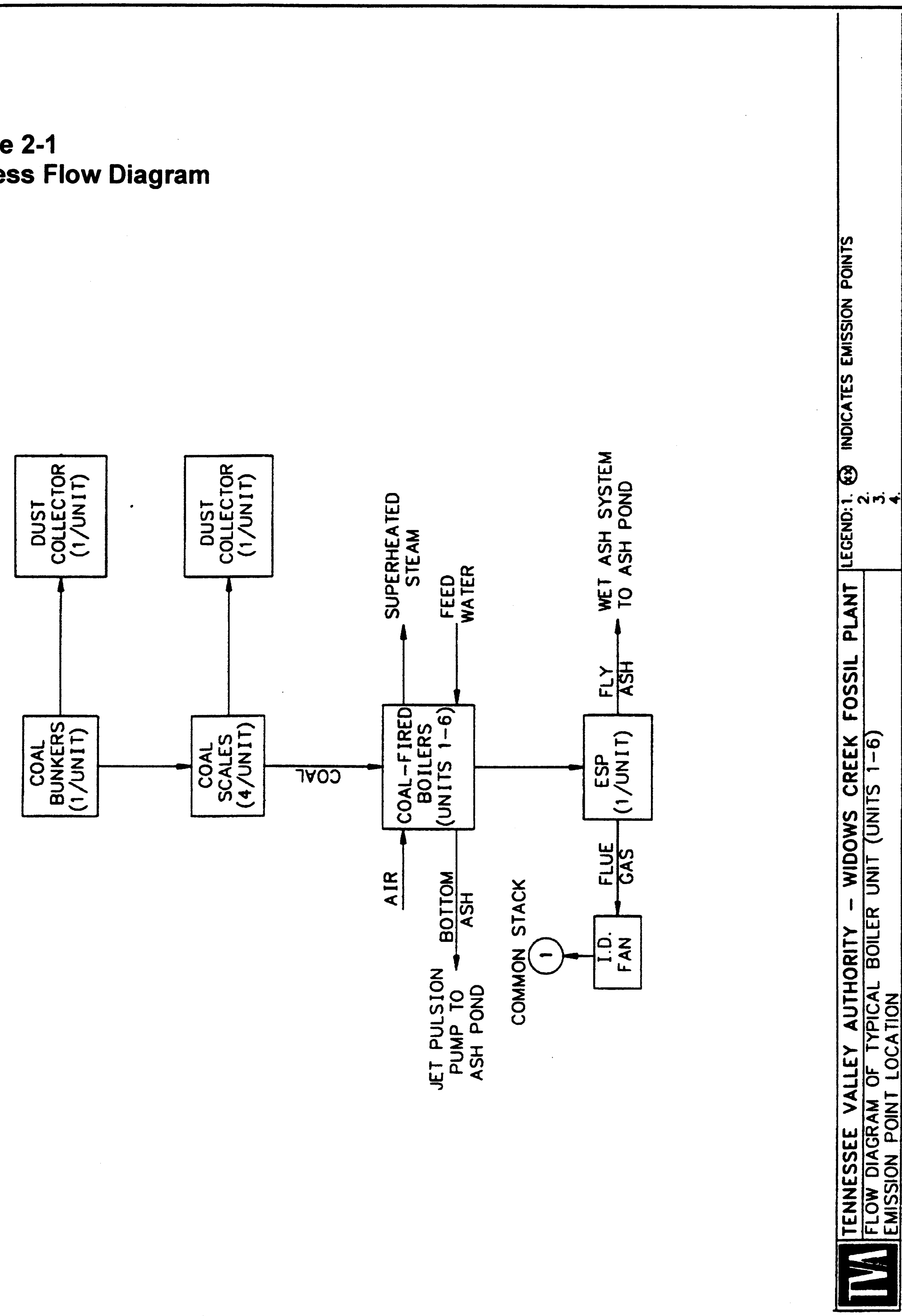


Figure 2-2
Description of sampling locations at Widows Creek Unit Number 6 Precipitator A Inlet Duct

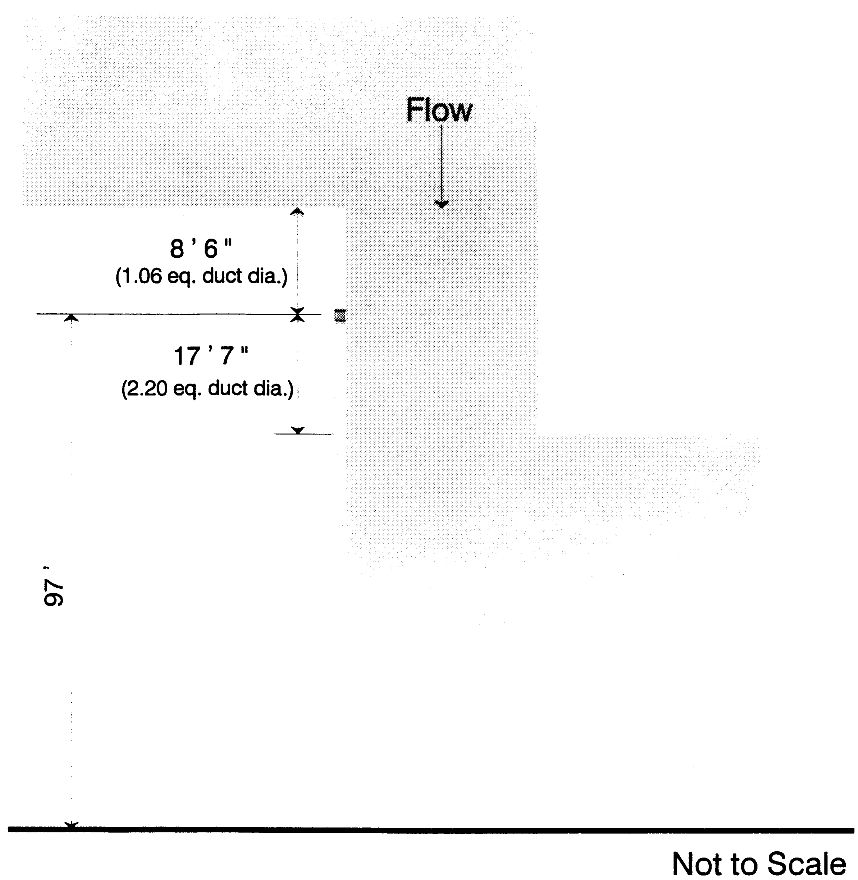


Figure 2-3
Description of sampling points at Widows Creek Unit Number 6 Precipitator A Inlet Duct

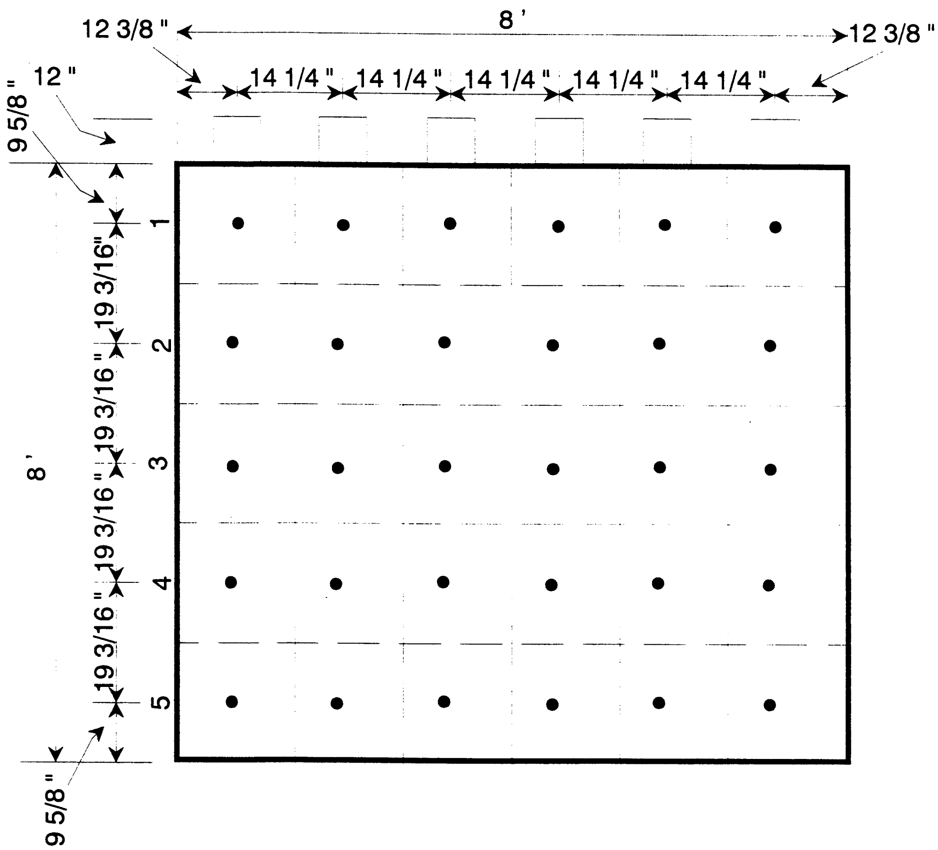
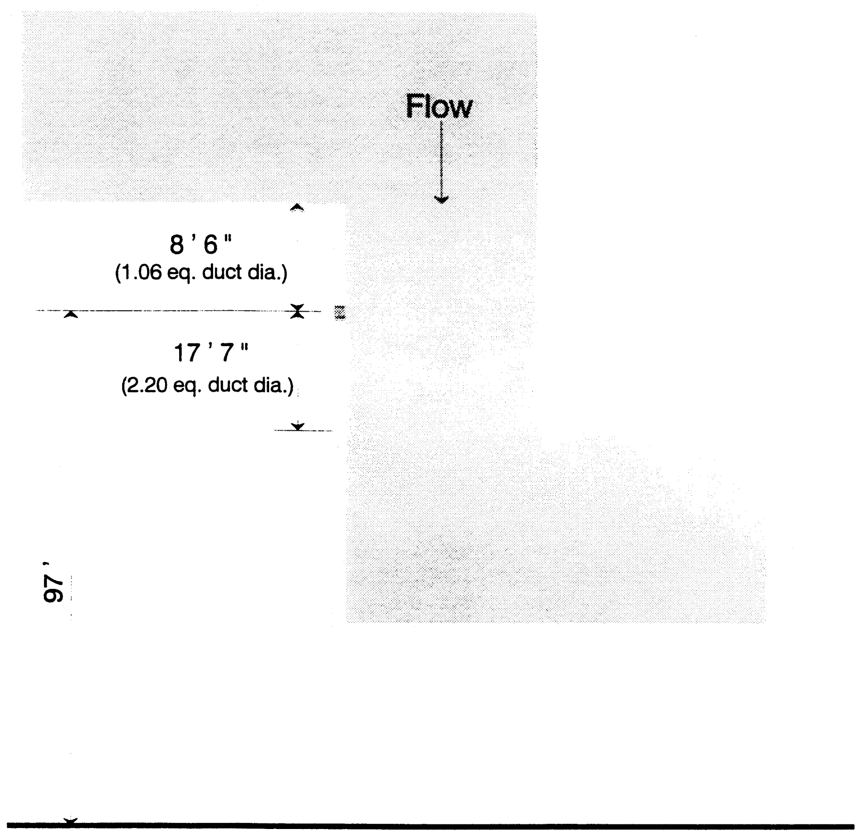


Figure 2-4
Description of sampling locations at Widows Creek Unit Number 6 Precipitator B Inlet Duct



Not to Scale

Figure 2-5
Description of sampling points at Widows Creek Unit Number 6 Precipitator B Inlet Duct

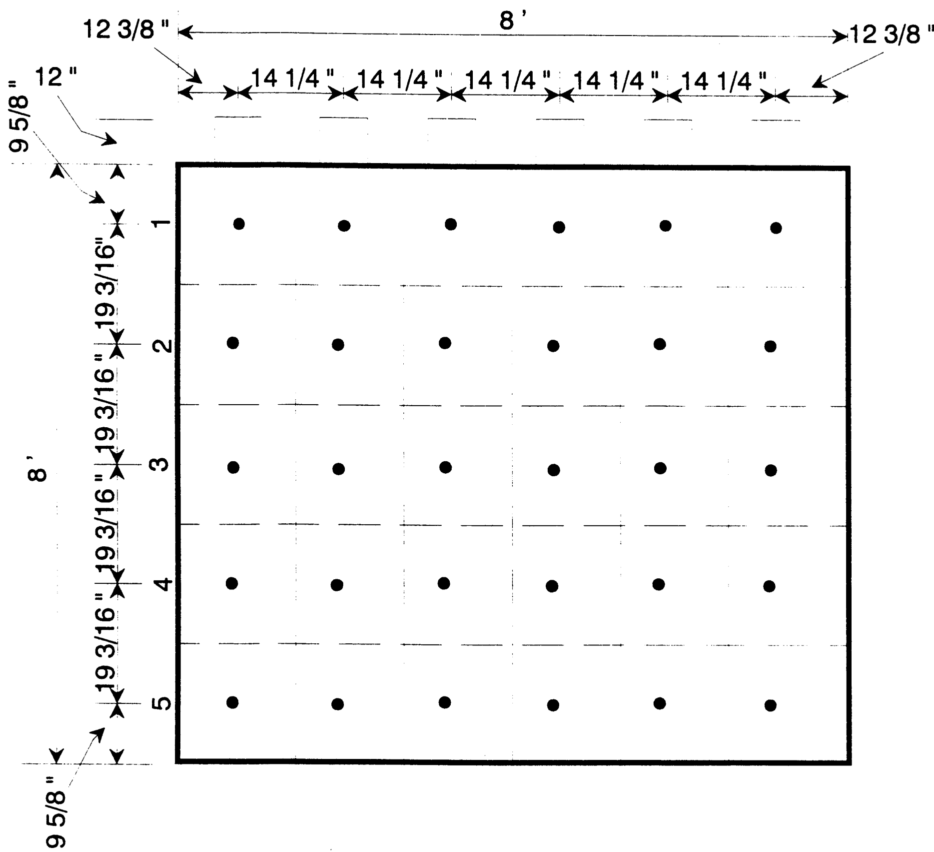


Figure 2-6
Description of sampling locations at Widows Creek Unit Number 6 Precipitator A Outlet Duct

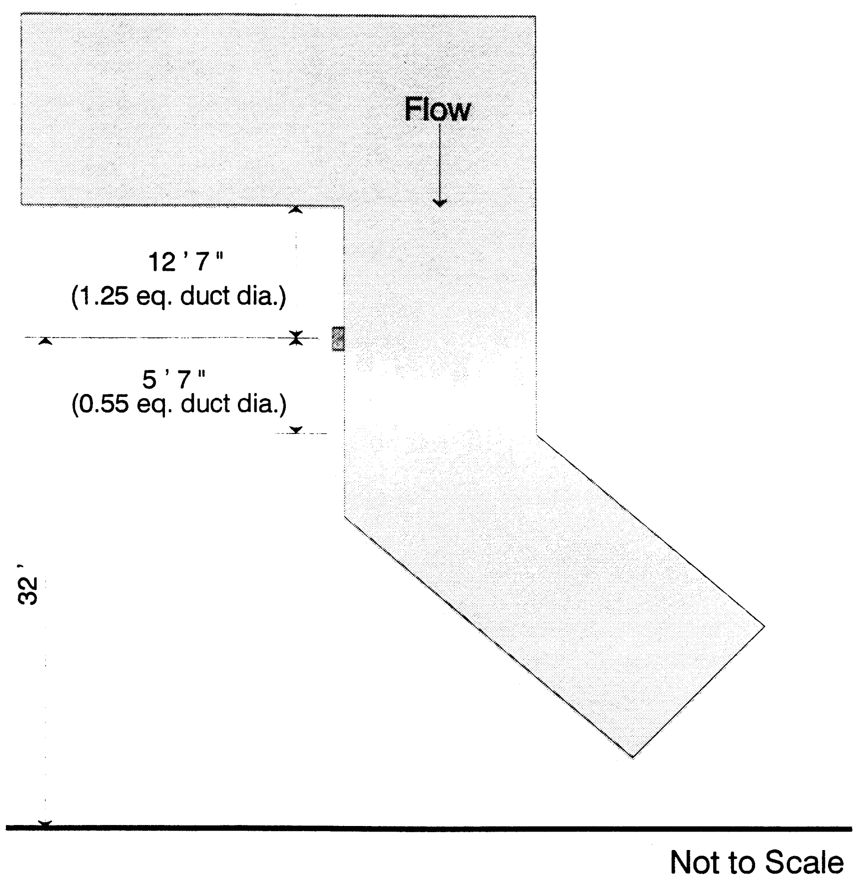


Figure 2-7
Description of sampling points at Widows Creek Unit Number 6 Precipitator A Outlet Duct

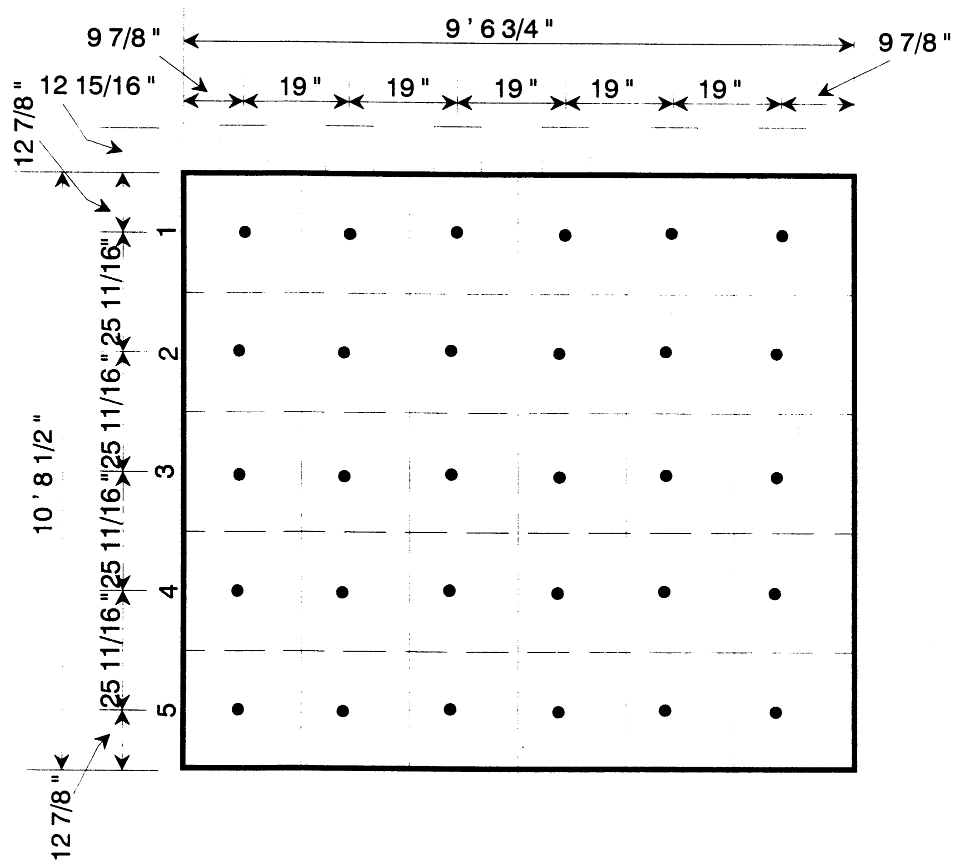


Figure 2-8
Description of sampling locations at Widows Creek Unit Number 6 Precipitator B Outlet Duct

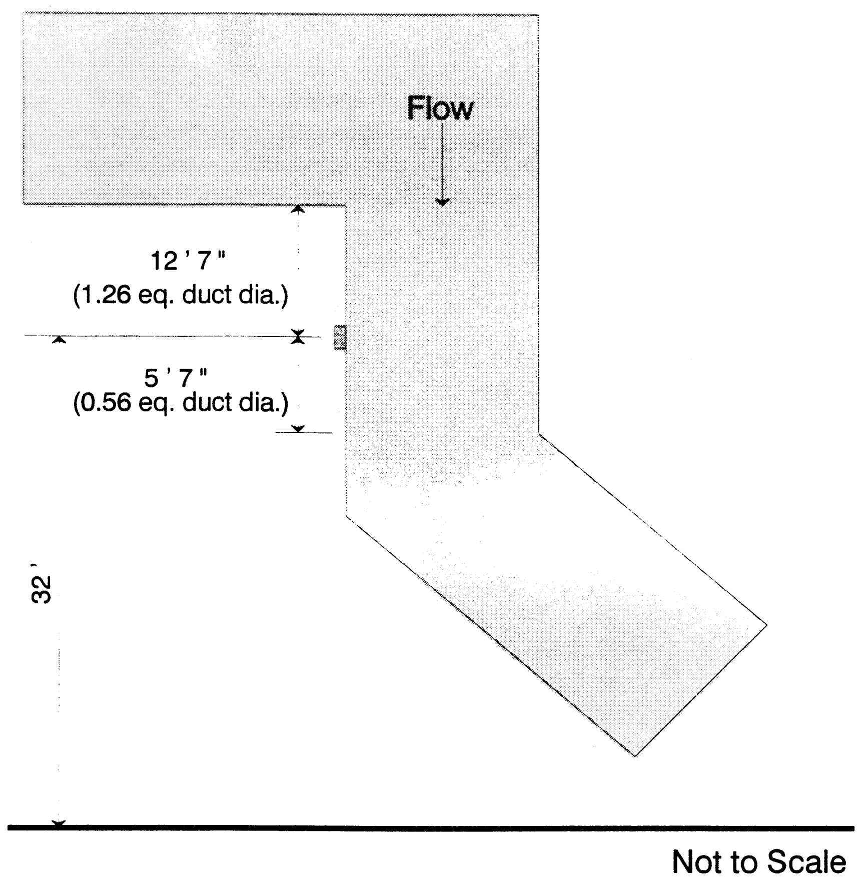


Figure 2-9
Description of sampling points at Widows Creek Unit Number 6 Precipitator B Outlet Duct

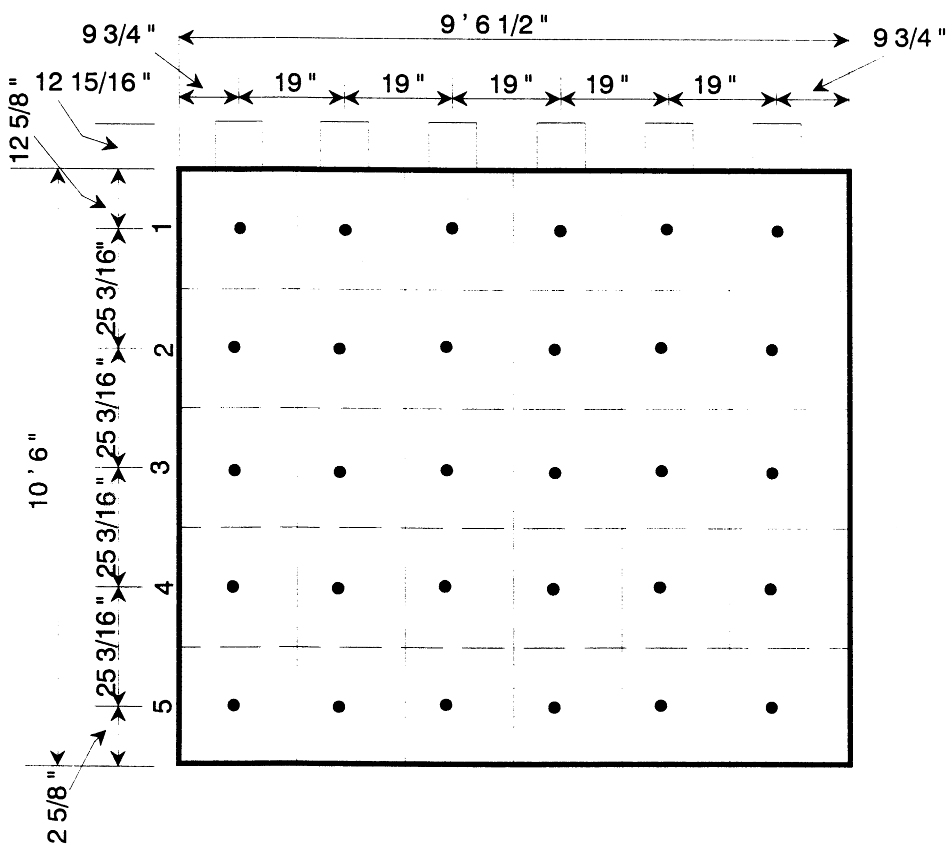
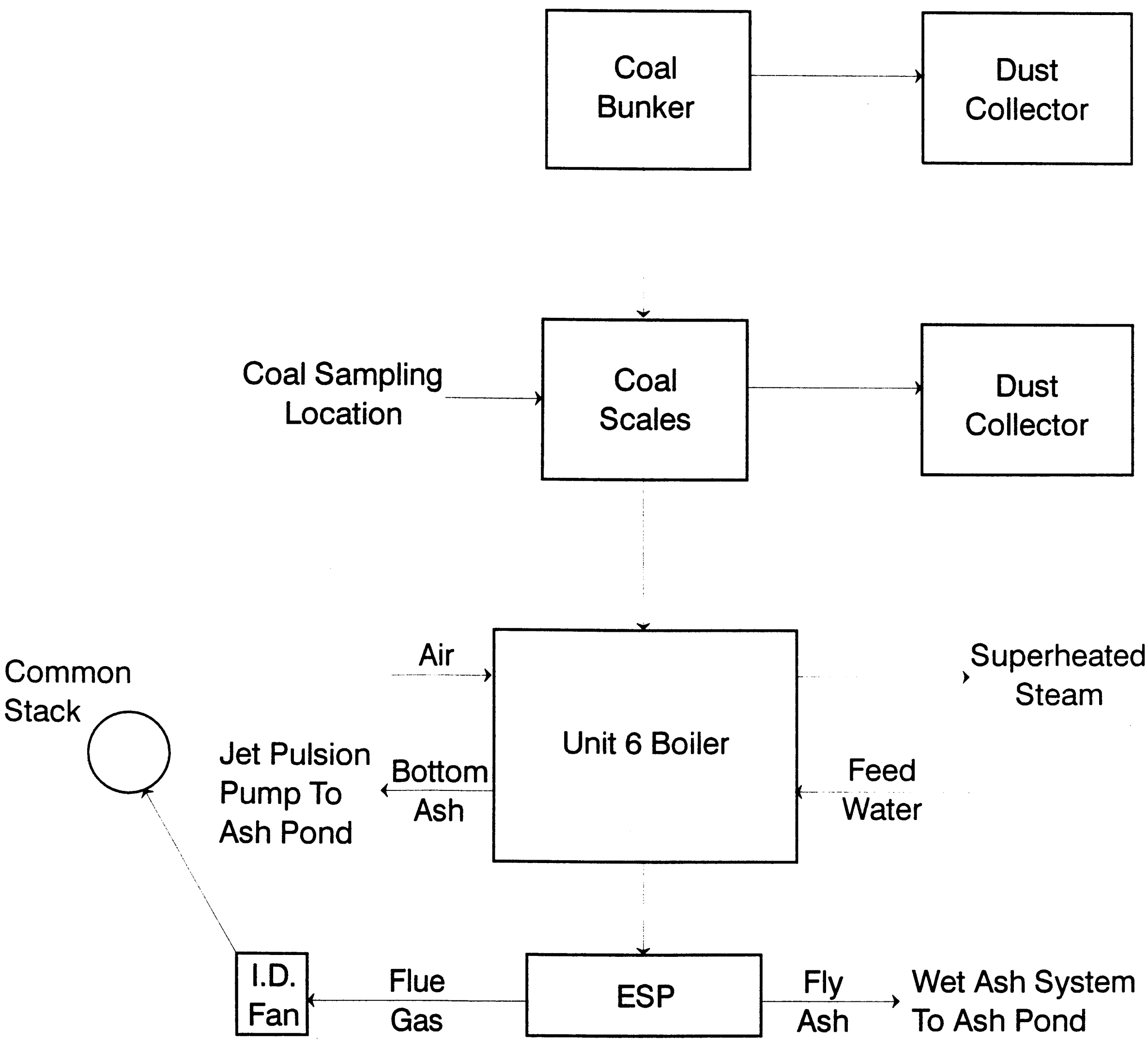


Figure 2-10
Description of coal sampling locations at Widows Creek Unit Number 6



3 SUMMARY AND DISCUSSION OF RESULTS

3.1 Objectives and Test Matrix

3.1.1 Objective

The objective of the tests was to collect the information and measurements required by the EPA Mercury ICR. Specific objectives listed in order of priority are:

1. Quantify speciated mercury emissions at the outlet.
2. Quantify speciated mercury concentrations in the flue gas at the inlet.
3. Quantify fuel mercury and chlorine content during the outlet and inlet tests.
4. Provide the above information for use in developing boiler, fuel, and specific control device mercury emission factors.

3.1.2 Test Matrix

The test matrix is presented in Table 3-1. The table includes a list of test methods to be used. In addition to speciated mercury, the flue gas measurements include moisture, flue gas flow rates, carbon dioxide, and oxygen.

Table 3-1
Test Matrix for Mercury ICR Tests at Widows Creek Unit Number 6

Sampling Location	No. of Runs	Species Measured	Sampling Method	Sample Run Time	Analytical Method	Analytical Laboratory
Outlet A	3	Speciated Hg	Ontario Hydro	150 min	Ontario Hydro	TestAmerica
Outlet A	3	Moisture	EPA 4	Concurrent	Gravimetric	METCO
Outlet A	3	Flue Gas Flow	EPA 1 & 2	Concurrent	Pitot Traverse	METCO
Outlet A	3	O_2 & CO_2	EPA 3B	Concurrent	Orsat	METCO
Inlet A	3	Speciated Hg	Ontario Hydro	150 min	Ontario Hydro	TestAmerica
Inlet A	3	Moisture	EPA 4	Concurrent	Gravimetric	METCO
Inlet A	3	Flue Gas Flow	EPA 1 & 2	Concurrent	Pitot Traverse	METCO
Inlet A	3	O_2 & CO_2	EPA 3B	Concurrent	Orsat	METCO
Outlet B	3	Moisture	EPA 4	30 min	Gravimetric	METCO
Outlet B	3	Flue Gas Flow	EPA 1 & 2	Concurrent	Pitot Traverse	METCO
Outlet B	3	O_2 & CO_2	EPA 3B	Concurrent	Orsat	METCO
Inlet B	3	Moisture	EPA 4	30 min	Gravimetric	METCO
Inlet B	3	Flue Gas Flow	EPA 1 & 2	Concurrent	Pitot Traverse	METCO
Inlet B	3	O_2 & CO_2	EPA 3B	Concurrent	Orsat	METCO
Coal Scales	3	Hg, Cl, Sulfur, Ash, and Btu/lb in coal	ASTM D2234	1 grab sample every 30-minutes per scale per run	ASTM D6414-99 (Hg), ASTM D2361-95 (Cl), ASTM D-0516 (S), ASTM D-3174 (Ash), and ASTM D-3286 (Btu/lb)	TestAmerica and Philip Services

3.2 Field Test Changes and Problems

No deviations were made from the approved Sampling and Analytical Test Plan.

3.3 Handling of Non-Detects

This section addresses how data will be handled in cases where no mercury is detected in an analytical fraction. It should be noted that the analytical method specified in the Ontario Hydro Method has a very low detection limit, which is expected to be well below flue gas levels for most cases if the laboratory uses normal care and state of the art analytical equipment. However, there may be cases where certain fractions of a test do not show detectable mercury levels. This section addresses how non-detects will be handled in calculating and reporting mercury levels.

3.3.1 A single analytical fraction representing a subset of a mercury species is not detected.

When more than one sample component is analyzed to determine a mercury species (such as analyzing the probe rinse and filter catch separately to determine total particulate mercury) and one fraction is not detected, it will be counted as zero. Total mercury for that species will be the sum of the detected values of the remaining fraction(s). For example, if the probe rinse had ND < 0.05 µg and the filter had 1.5 µg, total particulate mercury would be reported as 1.5 micrograms.

3.3.2 All fractions representing a mercury species are not detected.

If all fractions used to determine a mercury species are not detected, the total mercury for that species will be reported as not detected, at the sum of the detection limits of the individual species.

For example, if the probe rinse were not detected at 0.003 µg and the filter catch were not detected at 0.004 µg, the reported particulate mercury would be reported as ND <0.007 µg. This is expected to represent a small fraction (<1%) of the total mercury, even under worse case scenario of 1 µg/Nm^3.

3.3.3 No mercury is detected for a species on all three test runs.

When all three test runs show no detectable levels of mercury for a mercury species, that mercury species will be reported as not detected at less than the highest detection limit. For example, if three results for elemental mercury are ND < 0.10, ND <0.13, and ND < 0.10, the results would be reported as ND < 0.13 (the highest of the three detection levels).

In calculating total mercury, a value of zero will be used for that species. For example, if particulate mercury were ND < 0.11 µg, oxidized mercury were 2.0 µg, and elemental mercury were 3.0 µg, total mercury would be reported as 5.0 µg.

In calculating the percentage of mercury in the other two species, a value of zero will be used. For the example listed in the preceding paragraph, the results would be reported as 0% particulate mercury, 40% oxidized mercury, and 60% elemental mercury.

3.3.4 Mercury is detected on one or two of three runs.

If mercury is detected on one or two of three runs, average mercury will be calculated as the average of the detected value(s) and half of the detection limits for the non-detect(s).

Example 1: The results for three runs are 0.20, 0.20, and ND < 0.10. The reported value would be calculated as the average of 0.20, 0.20, and 0.05, which is 0.15 µg.

Example 2: The results for three runs are 0.14, ND < 0.1, and ND < 0.1. The average of 0.14, 0.05, and 0.05 is calculated to be 0.08. Since this is below the detection limit of 0.1, the reported value is ND < 0.1.

3.4 Summary of Results

The results of the tests performed at Widows Creek Unit Number 6 are listed in the following tables.

Table 3-2
Widows Creek Unit Number 6 Precipitator A Source Emissions Results

Run Number	**1**	**2**	**3**
Test Date	10/20/99	10/20/99	10/21/99
Test Time	0915-1151	1300-1536	0800-1035
Inlet Gas Properties			
Flow Rate - ACFM	213,076	215,602	219,741
Flow Rate – DSCFM*	128,519	129,867	132,646
% Water Vapor - % Vol.	7.73	7.29	7.60
CO_2 - %	14.0	13.4	14.0
O_2 - %	5.2	5.6	5.0
% Excess Air @ Sampling Point	32	35	30
Temperature - °F	320	323	318
Pressure – "Hg	28.79	28.72	28.70
Percent Isokinetic	102.0	100.3	95.4
Volume Dry Gas Sampled – DSCF*	66.789	66.365	64.466
Outlet Gas Properties			
Flow Rate – ACFM	236,176	229,613	234,973
Flow Rate – DSCFM*	143,266	140,761	145,335
% Water Vapor - % Vol.	6.95	6.53	6.79
CO_2 - %	11.0	11.8	11.6
O_2 - %	8.2	7.2	7.6
% Excess Air @ Sampling Point	62	51	55
Temperature - °F	324	316	304
Pressure – "Hg	28.85	28.74	28.62
Percent Isokinetic	95.6	99.8	98.3
Volume Dry Gas Sampled – DSCF*	55.661	57.126	58.087

* 29.92 "Hg, 68 °F (760 mm Hg, 20 °C)

Table 3-3
Widows Creek Unit Number 6 Precipitator B Source Emissions Results

Run Number	**1**	**2**	**3**
Inlet Gas Properties			
Test Date	10/20/99	10/20/99	10/21/99
Test Time	0810-0840	1202-1232	0717-0747
Flow Rate - ACFM	210,546	205,104	211,171
Flow Rate – DSCFM*	129,593	126,814	129,737
% Water Vapor - % Vol.	6.33	5.94	6.50
CO_2 - %	12.0	11.2	11.8
O_2 - %	6.6	7.2	7.0
% Excess Air @ Sampling Point	44	50	48
Temperature - °F	315	315	314
Pressure – "Hg	28.75	28.76	28.71
Volume Dry Gas Sampled – DSCF*	22.126	22.271	21.724
Outlet Gas Properties			
Test Date	10/20/99	10/20/99	10/21/99
Test Time	1026-1056	1322-1352	0826-0856
Flow Rate – ACFM	240,725	241,597	240,488
Flow Rate – DSCFM*	149,245	153,614	149,269
% Water Vapor - % Vol.	6.40	6.02	6.74
CO_2 - %	11.6	11.2	11.0
O_2 - %	6.8	7.6	7.8
% Excess Air @ Sampling Point	46	55	57
Temperature - °F	311	292	301
Pressure – "Hg	28.83	28.73	28.60
Volume Dry Gas Sampled – DSCF*	21.197	21.085	21.556

* 29.92 "Hg, 68 °F (760 mm Hg, 20 °C)

Table 3-4
Widows Creek Unit Number 6 Precipitator Mercury Removal Efficiency

Run Number	1	2	3	Average
Test Date	10/20/99	10/20/99	10/21/99	
Test Time	0915-1151	1300-1536	0800-1035	
Total mercury				
Inlet - lbs/10^{12} Btu	2.40	2.13	2.05	2.19
Outlet - lbs/10^{12} Btu	1.15	0.92	0.01	0.69
Removal efficiency - %	52.1	56.8	99.5	69.5
Inlet - lbs/hr Btu	2.85E-3	2.45E-3	2.51E-3	2.60E-3
Outlet - lbs/hr Btu	1.25E-3	1.09E-3	8.05E-6	7.83E-4
Removal efficiency - %	56.1	55.5	99.7	70.4
Particulate mercury				
Inlet - lbs/10^{12} Btu	2.40	2.13	2.05	2.19
Outlet - lbs/10^{12} Btu	0.10	0.01	0.01	0.04
Removal efficiency - %	95.8	99.5	99.5	98.3
Inlet - lbs/hr Btu	2.85E-3	2.45E-3	2.51E-3	2.60E-3
Outlet - lbs/hr Btu	1.06E-4	1.43E-5	8.05E-6	4.28E-5
Removal efficiency - %	96.3	99.4	99.7	98.5
Oxidized mercury				
Inlet - lbs/10^{12} Btu	<0.64	<0.64	<0.66	<0.66
Outlet - lbs/10^{12} Btu	1.05	0.91	<0.93	<0.81
Removal efficiency - %	-----	-----	-----	-----
Inlet - lbs/hr Btu	<7.57E-4	<7.37E-4	<8.13E-4	<8.13E-4
Outlet - lbs/hr Btu	1.15E-3	1.08E-3	1.07E-3	9.22E-4
Removal efficiency - %	-----	-----	-----	-----
Elemental mercury				
Inlet - lbs/10^{12} Btu	<0.77	<0.73	<0.71	<0.77
Outlet - lbs/10^{12} Btu	<1.15	<0.97	<0.96	<1.15
Removal efficiency - %	-----	-----	-----	-----
Inlet - lbs/hr Btu	<9.10E-4	<8.39E-4	<8.67E-4	<9.10E-4
Outlet - lbs/hr Btu	<1.25E-3	<1.15E-3	<1.10E-3	<1.25E-3
Removal efficiency - %	-----	-----	-----	-----

Table 3-5 Widows Creek Unit Number 6 Mercury Speciation Results

Run Number	1	2	3	Average
Test Date	10/20/99	10/20/99	10/21/99	
Test Time	0915-1151	1300-1536	0800-1035	
A Inlet Mercury Speciation				
Particulate mercury – µg	5.58	4.79	4.66	—
µg/dscm	2.95	2.55	2.55	2.68
lbs/hr*	2.85E-3	2.45E-3	2.51E-3	2.60E-3
lbs/10^{12} Btu	2.40	2.13	2.05	2.19
% of total Hg	100.0	100.0	100.0	100.0
Oxidized mercury – µg	<1.48	<1.44	<1.51	—
µg/dscm	<0.78	<0.77	<0.83	<083
lbs/hr*	<7.57E-4	<7.37E-4	<8.13E-4	<8.13E-4
lbs/10^{12} Btu	<0.64	<0.64	<0.66	<0.66
% of total Hg	0.0	0.0	0.0	0.0
Elemental mercury - µg	<1.78	<1.64	<1.61	—
µg/dscm	<0.94	<0.87	<0.88	<0.94
lbs/hr*	<9.10E-4	<8.39E-4	<8.67E-4	<9.10E-4
lbs/10^{12} Btu	<0.77	<0.73	<0.71	<0.77
% of total Hg	0.0	0.0	0.0	0.0
Total mercury – µg	5.58	4.79	4.66	—
µg/dscm	2.95	2.55	2.55	2.68
lbs/hr*	2.85E-3	2.45E-3	2.51E-3	2.60E-3
lbs/10^{12} Btu	2.40	2.13	2.05	2.19
A Outlet Mercury Speciation				
Particulate mercury – µg	0.152	0.021	0.012	—
µg/dscm	0.10	0.01	0.01	0.04
lbs/hr*	1.06E-4	1.43E-5	8.05E-6	4.28E-5
lbs/10^{12} Btu	0.10	0.01	0.01	0.04
% of total Hg	8.7	1.1	100.0	36.6
Oxidized mercury – µg	1.65	1.58	<1.60	—
µg/dscm	1.05	0.98	<0.97	<0.84
lbs/hr*	1.15E-3	1.08E-3	1.07E-3	9.22E-4
lbs/10^{12} Btu	1.05	0.91	<0.93	<0.81
% of total Hg	91.3	98.9	0.0	95.1
Elemental mercury - µg	<1.80	<1.68	<1.64	
µg/dscm	<1.14	<1.04	<1.00	<1.14
lbs/hr*	<1.25E-3	<1.15E-3	<1.10E-3	<1.25E-3
lbs/10^{12} Btu	<1.15	<0.97	<0.96	<1.15
% of total Hg	0.0	0.0	0.0	0.0
Total mercury – µg	1.802	1.601	0.012	—
µg/dscm	1.14	0.99	0.01	0.71
lbs/hr*	1.25E-3	1.09E-3	8.05E-6	7.83E-4
lbs/10^{12} Btu	1.15	0.92	0.01	0.69
Coal Analysis				
Mercury - ppm dry	0.029	0.024	0.021	0.025
Mercury - lb/10^{12} Btu	2.63	2.49	1.66	2.26
Chlorine - ppm dry	400	300	300	333
Moisture - %	8.89	9.45	9.23	9.19
Sulfur - % dry	0.59	0.51	0.53	0.54
Ash - % dry	11.4	10.4	10.2	10.7
HHV - Btu/lb as fired	11,510	11,540	11,590	11,547
Coal Flow - lb/hr as fired	99,963	101,087	98,491	99,847
Total Heat Input – 10^6 Btu/hr**	1,150.6	1,166.5	1,141.5	1,152.9
Total Mercury Mass Rates				
lb/hr Input in Coal	2.90E-3	2.43E-3	2.07E-3	2.47E-3
lbs/hr* at Precipitator Inlet	2.85E-3	2.45E-3	2.51E-3	2.60E-3
lbs/hr* emitted	1.25E-3	1.09E-3	8.05E-6	7.83E-4

* Calculated using the combined inlet and outlet flow rates (A and B), respectively.

** Calculated based on the outlet flow rate (A and B), F_d factor, and measured oxygen content.

Table 3-6
Widows Creek Unit Number 6 Process Data

Run Number	**1**	**2**	**3**
Test Date	10/20/99	10/20/99	10/21/99
Test Time	0915-1151	1300-1536	0800-1035
Unit Operation			
Unit Load - MW net	119.49	119.71	119.99
Coal Mills in Service	A,B,C, & D	A,B,C, & D	A,B,C, & D
Coal Flow - lbs/hr*	99,059	104,298	104,210
Coal Flow – lbs/hr**	99,963	101,087	98,491
Precipitator A CEMS data			
O_2 - %	2.93	2.95	3.26
Opacity – %	10.54	9.86	11.64
Precipitator B CEMS data			
O_2 - %	4.91	4.56	5.18
Opacity – %	21.01	23.15	22.21

* Only two of the four coal scales used to measure coal flow were in operation. Data from the two working scales was averaged and assumed for the other two scales. Mill amps and Δ P were very similar for all mills, with the exception of mill D, which did not have a working coal scale. Mill amps and Δ P were slightly higher, therefore, the estimated coal flow could be estimated low.

** Data calculated using the measured outlet gas flow rates (dscfm), HHV Btu/hr, and the Oxygen based F factor of 9,780 dscf/million Btu.

4 SAMPLING AND ANALYTICAL PROCEDURES

4.1 Emission Test Methods

The sampling followed the procedures set forth in the Code of Federal Regulations, Title 40, Chapter I, Part 60, Appendix A, Methods 1, 2, 3B, 4, 5, 17, and 19; in the "Standard Test Method for Elemental, Oxidized, Particle-bound, and Total Mercury in Flue Gas Generated from Coal-Fired Stationary Sources (Ontario Hydro Method), Revised July 7, 1999; and ASTM Methods D2234, D6414-99, D2361-95, D-0516, D-3174, and D-3286.

A preliminary velocity traverse was made at each of the six ports at the A inlet sampling location, in order to determine the uniformity and magnitude of the flow prior to testing. All traverse points were checked for cyclonic flow and the average angle was equal to 1.4 degrees. Alternate procedures would be required if the angle of cyclonic flow was greater than 20 degrees. Five traverse points were sampled from each of the six ports, for a total of thirty traverse points.

A preliminary velocity traverse was made at each of the six ports at the B inlet sampling location, in order to determine the uniformity and magnitude of the flow prior to testing. All traverse points were checked for cyclonic flow and the average angle was equal to 1.3 degrees. Alternate procedures would be required if the angle of cyclonic flow was greater than 20 degrees. Five traverse points were sampled from each of the six ports, for a total of thirty traverse points.

A preliminary velocity traverse was made at each of the six ports at the A outlet sampling locations, in order to determine the uniformity and magnitude of the flow prior to testing. All traverse points were checked for cyclonic flow and the average angle was equal to 2.1 degrees. Alternate procedures would be required if the angle of cyclonic flow was greater than 20 degrees. Five traverse points were sampled from each of the six ports, for a total of thirty traverse points.

A preliminary velocity traverse was made at each of the six ports at the B outlet sampling locations, in order to determine the uniformity and magnitude of the flow prior to testing. All traverse points were checked for cyclonic flow and the average angle was equal to 1.0 degrees. Alternate procedures would be required if the angle of cyclonic flow was greater than 20 degrees. Five traverse points were sampled from each of the six ports, for a total of thirty traverse points.

The sampling trains were leak-checked at the end of the nozzle at 15 inches of mercury vacuum before each test, and again after each test at the highest vacuum reading recorded during each test. This was done to predetermine the possibility of a diluted sample.

The pitot tube lines were checked for leaks before and after each test under both a vacuum and a pressure. The lines were also checked for clearance and the manometer was zeroed before each test.

Integrated orsat samples were collected and analyzed according to EPA Method 3B during each test.

4.1.1 Mercury

Triplicate samples for mercury were collected. The samples were taken according to EPA Methods 1, 2, 3B, 4, 5, and 17; and the Ontario Hydro Method, Revised July 7, 1999. For each run at both sampling locations, samples of five-minute duration were taken isokinetically at each of the thirty traverse points for a total sampling time of 150 minutes. Data was recorded at five-minute intervals. Reagent blanks and field blanks were submitted.

The "front-half" of the sampling train at the inlet sampling location contained the following components:

Teflon Coated Nozzle
In-stack Quartz Fiber Thimble and Backup Filter and Teflon Coated Support
Heated Glass Probe @ > 248°F

The "front-half" of the sampling train at the outlet sampling location contained the following components:

Teflon Coated Nozzle
In-stack Quartz Fiber Filter and Teflon Coated Support
Heated Glass Probe @ > 248°F

The "back-half" of the sampling train contained the following components:

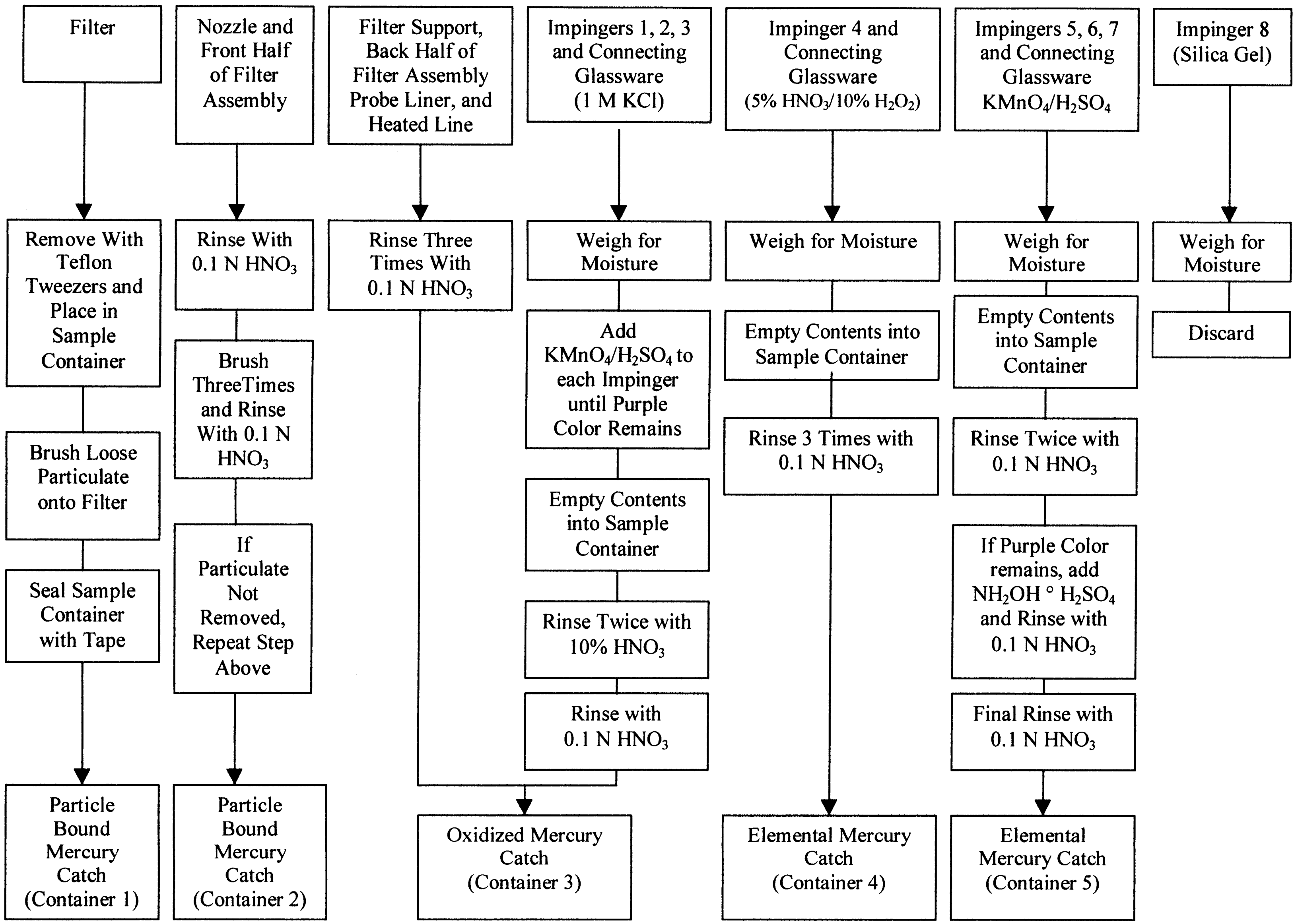
Impinger Number	Impinger Type	Impinger Contents	Amount	Parameter Collected
1	Modified Design	1 mol/L KCL	100 ml	Oxidized Mercury and Moisture
2	Modified Design	1 mol/L KCL	100 ml	Oxidized Mercury and Moisture
3	Greenburg-Smith Design	1 mol/L KCL	100 ml	Oxidized Mercury and Moisture
4	Modified Design	5% HNO_3 and 10% H_2O_2	100 ml	Elemental Mercury and Moisture
5	Modified Design	4% $KMnO_4$ and 10% H_2SO_4	100 ml	Elemental Mercury and Moisture
6	Modified Design	4% $KMnO_4$ and 10% H_2SO_4	100 ml	Elemental Mercury and Moisture
7	Greenburg-Smith Design	4% $KMnO_4$ and 10% H_2SO_4	100 ml	Elemental Mercury and Moisture
8	Modified Design	Silica	200 g	Moisture

All glassware was cleaned prior to use according to the guidelines outlined in EPA Method 29, Section 5.1.1 and the Ontario Hydro Method, Revised July 7, 1999, Section 13.2.15. All glassware connections were sealed with Teflon tape.

At the conclusion of each test, the filter and impinger contents were recovered according to procedures outlined in the Ontario Hydro Method, Revised July 7, 1999, Section 13.2.

Mercury samples were analyzed by Cold Vapor Atomic Absorption and Fluorescence Spectroscopy.

Figure 4-1 Sample Recovery Scheme for the Mercury Speciation Sampling Train Ash Sample (Method 17 Configuration)



4.1.2 Moisture

The samples were taken according to EPA Methods 3B and 4. Samples of thirty-minute duration were taken from a single point. Data was recorded in five-minute intervals.

The "front-half" of the sampling train at the outlet sampling location contained the following components:

In-stack Quartz Fiber Filter and Teflon Coated Support
Heated Glass Probe @ > 248°F

The "back-half" of the sampling train contained the following components:

Impinger Number	Impinger Type	Impinger Contents	Amount	Parameter Collected
1	Modified Design	6% Hydrogen Peroxide	100 ml	Moisture
2	Greenburg-Smith Design	6% Hydrogen Peroxide	100 ml	Moisture
3	Modified Design	6% Hydrogen Peroxide	100 ml	Moisture
4	Modified Design	Silica	200 g	Moisture

4.2 Process Test Methods

ASTM D2234 method of coal sampling was followed. For each test run, a grab sample of coal was collected from each coal scale immediately downstream of the coal bunkers. One composite sample was prepared for analysis from the individual feeder samples. Each sample was analyzed for mercury, chlorine, sulfur, ash, and Btu content by ASTM Methods D6414-99, D2361-95, D-0516, D-3174, and D-3286 respectively.

4.3 Sample Tracking and Custody

Samples and reagents were maintained in limited access, locked storage at all times prior to the test dates. While on site, they were at an attended location or in an area with limited access. Off site, METCO and TestAmerica provided limited access, locked storage areas for maintaining custody.

Chain of custody forms are located in Appendix F. The chain of custody forms provide a detailed record of custody during sampling, with the initials noted of the individuals who loaded and recovered impinger contents and filters, and performed probe rinses.

All samples were packed and shipped in accordance with regulations for hazardous substances.

5 QA/QC ACTIVITIES

The major project quality control checks are listed in Table 5-1. Matrix Spike Summaries are listed in Table 5-2. Duplicate and Triplicate Analyses Summaries are listed in Table 5-3. Additional method-specific QC checks are presented in Table 5-4 (Methods 1 and 2), Table 5-5 (Method 5/17 sampling), and Table 5-6 (Ontario Hydro sample recovery and analysis). These tables also include calibration frequency and specifications.

Table 5-1 Major Project Quality Control Checks

QC Check	***Information Provided***	***Results***
Blanks		
Reagent blank	Bias from contaminated reagent	No Mercury was detected
Field blank	Bias from handling and glassware	No Mercury was detected
Spikes		
Matrix spike	Analytical bias	Sample results were between 75% - 125% recovery
Replicates		
Duplicate analyses	Analytical precision	Results were < 10% RPD
Triplicate analyses	Analytical precision	Results were < 10% RPD

Table 5-2 Unit Number 6 Precipitator Matrix Spike Summary

Sampling Location	*Run Number*	*Container*	*Results (ug)*	*True Value (ug)*	*Recover (%)*
A Inlet Duct	1	1A	7.26	6.69	109
A Inlet Duct	2	2	1.02	0.96	106
A Inlet Duct	3	3	8.23	7.55	109
A Outlet Duct	1	1A	0.052	0.050	103
A Outlet Duct	Blank Train	5	4.90	5.05	97
A Outlet Duct	Blank Train	4	2.92	3.10	94

Table 5-3
Unit Number 6 Precipitator Duplicate and Triplicate Analyses Summary

Sampling Location	*Run Number*	*Container*	*Results (ug)*	*Duplicate Results (ug)*	*RPD*	*Triplicate Results (ug)*	*RPD*
A Inlet Duct	1	1A	5.58	5.47	2	-----	-----
		1B	<0.01	<0.01	0	-----	-----
		2	<0.21	<0.21	0	<0.210	0
		3	<1.48	<1.48	0	-----	-----
		4	<0.78	<0.78	0	-----	-----
		5	<1.0	<1.0	0	-----	-----
	2	1A	4.79	4.96	3.6	-----	-----
		1B	<0.01	<0.01	0	-----	-----
		2	<0.192	<0.192	0	-----	-----
		3	<1.44	<1.44	0	<1.44	0
		4	<0.68	<0.68	0	-----	-----
		5	<0.96	<0.96	0	-----	-----
	3	1A	4.66	4.67	0.2	4.59	1.5
		1B	<0.01	<0.01	0	-----	-----
		2	<0.148	<0.148	0	-----	-----
		3	<1.51	<1.51	0	-----	-----
		4	<0.64	<0.64	0	-----	-----
		5	<0.97	<0.97	0	-----	-----
A Outlet Duct	1	1A	0.028	0.029	3.5	-----	-----
		2	0.124	0.124	0	-----	-----
		3	1.65	1.72	4.4	-----	-----
		4	<0.82	<0.82	0	-----	-----
		5	<0.98	<0.98	0	-----	-----
	2	1A	0.021	0.020	2.0	-----	-----
		2	<0.082	<0.082	0	-----	-----
		3	1.58	1.60	1.3	-----	-----
		4	<0.74	<0.74	0	-----	-----
		5	<0.94	<0.94	0	-----	-----
	3	1A	0.012	0.012	0	-----	-----
		2	<0.180	<0.180	0	-----	-----
		3	<1.60	<1.60	0	-----	-----
		4	<0.68	<0.68	0	-----	-----
		5	<0.96	<0.96	0	-----	-----

Table
5-4 QC Checklist and Limits for Methods 1 and 2

Quality Control Activity	Acceptance Criteria and Frequency	Reference
Measurement site evaluation	>2 diameters downstream and 0.5 diameters upstream of disturbances*	Method 1, Section 2.1
Pitot tube inspection	Inspect each use for damage, once per program for design tolerances	Method 2, Figures 2-2 and 2-3
Thermocouple	+/- 1.5% (°R) of ASTM thermometer, before and after each test mobilization	Method 2, Section 4.3
Barometer	Calibrate each program vs. mercury barometer or vs. weather station with altitude correction	Method 2, Section 4.4

* Although the inlet and outlet sampling locations do not meet the requirements of EPA Method 1, three-dimensional flow testing as described in EPA Method 1 was not performed. All traverse points were check for cyclonic flow at each sampling location. The average angle of flow at the inlet was 1.4 degrees and the average angle of flow at the outlet was 2.1 degrees.

Table 5-5 QC Checklist and Limits for Method 5/17 Sampling

Quality Control Activity	Acceptance Criteria and Frequency	Reference
Pre-mobilization checks		
Gas meter/orifice check	Before test series, Y_D +/- 5% (of original Y_D)	Method 5, Section 5.3
Probe heating system	Continuity and resistance check on element	
Nozzles	Note number, size, material	
Glassware	Inspect for cleanliness, compatibility	
Thermocouples	Same as Method 2	
On-site pre-test checks		
Nozzle	Measure inner diameter before first run	Method 5, Section 5.1
Probe heater	Confirm ability to reach temperature	
Pitot tube leak check	No leakage	Method 2, Section 3.1
Visible inspection of train	Confirm cleanliness, proper assembly	
Sample train leak check	$\leq$0.02 cf at 15" Hg vacuum	Method 5, Section 4.1.4
During testing		
Probe and filter temperature	Monitor and confirm proper operation	
Manometer	Check level and zero periodically	
Nozzle	Inspect for damage or contamination after each traverse	Method 5, Section 5.1
Probe/nozzle orientation	Confirm at each point	
Post test checks		
Sample train leak check	$\leq$0.02 cf at highest vacuum achieved during test	Method 5, Section 4.1.4
Pitot tube leak check	No leakage	Method 2, Section 3.1
Isokinetic ratio	Calculate, must be 90-110%	Method 5, Section 6
Dry gas meter calibration check	After test series, Y_D +/- 5%	Method 5, Section 5.3
Thermocouples	Same as Method 2	
Barometer	Compare w/ standard, +/- 0.1" Hg	

Table 5-6 QC Checklist and Limits for Ontario Hydro Mercury Speciation

Quality Control Activity	Acceptance Criteria and Frequency	Reference
Pre-mobilization activities		
Reagent grade	ACS reagent grade	Ontario Hydro Section 8.1
Water purity	ASTM Type II, Specification D 1193	Ontario Hydro Section 8.2
Sample filters	Quartz; analyze blank for Hg before test	Ontario Hydro Section 8.4.3
Glassware cleaning	As described in Method	Ontario Hydro Section 8.10
On-site pre-test activities		
Determine SO_2 concentration	If >2500 ppm, add more HNO_3-H_2O_2 solution	Ontario Hydro Section 13.1.13
Prepare KCl solution	Prepare batch as needed	Ontario Hydro Section 8.5
Prepare HNO_3-H_2O_2 solution	Prepare batch as needed	Ontario Hydro Section 8.5
Prepare H_2SO_4-$KMnO_4$ solution	Prepare daily	Ontario Hydro Section 8.5
Prepare HNO_3 rinse solution	Prepare batch as needed; can be purchased premixed	Ontario Hydro Section 8.6
Prepare hydroxylamine solution	Prepare batch as needed	Ontario Hydro Section 8.6
Sample recovery activities		
Brushes and recovery materials	No metallic material allowed	Ontario Hydro Section 13.2.6
Check for $KMnO_4$ Depletion	If purple color lost in first two impingers, repeat test with more HNO_3-H_2O_2 solution	Ontario Hydro Section 13.1.13
Probe cleaning	Move probe to clean area before cleaning	Ontario Hydro Section 13.2.1
Impinger 1,2,3 recovery.	After rinsing, add permanganate until purple color remains to assure Hg retention	Ontario Hydro Section 13.2.8
Impinger 5,6,7 recovery.	If deposits remain after HNO_3 rinse, rinse with hydroxylamine sulfate. If purple color disappears after hydroxylamine sulfate rinse, add more permangante until color returns	Ontario Hydro Section 13.2.10
Impinger 8	Note color of silica gel; if spent, regenerate or dispose.	Ontario Hydro Section 13.2.11
Blank samples		
0.1 N HNO_3 rinse solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
KCl solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
HNO_3-H_2O_2 solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
H_2SO_4-$KMnO_4$ solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
Hydroxylamine sulfate solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
Unused filters	Three from same lot.	Ontario Hydro Section 13.2.12
Field blanks	One per set of tests at each test location.	Ontario Hydro Section 13.4.1
Laboratory activities		
Assess reagent blank levels	Target <10% of sample value or <10x instrument detection limit. Subtract as allowed.	Ontario Hydro Section 13.4.1
Assess field blank levels	Compare to sample results. If greater than reagent blanks or greater than 30% of sample values, investigate. Subtraction of field blanks not allowed.	Ontario Hydro Section 13.4.1
Duplicate/triplicate samples	All CVAAS runs in duplicate; every tenth run in triplicate. All samples must be within 10% of each other; if not, recalibrate and reanalyze.	Ontario Hydro Section 13.4.1

6 DESCRIPTION OF TESTS

Personnel from METCO Environmental arrived at the plant at 1:30 p.m. on Tuesday, October 19, 1999. After meeting with plant personnel and attending a brief safety meeting, the equipment was moved onto the Unit Number 6 Precipitator A & B Inlet Ducts and Outlet Ducts. The preliminary data was collected. The equipment was secured for the night. All work was completed at 6:30 p.m.

On Wednesday, October 20, work began at 7:00 a.m. The equipment was prepared for testing. The first test for flow rate on the Precipitator B Inlet Duct began at 8:10 a.m. Testing continued until the completion of the second test at 12:32 p.m. The first test for flow rate on the Precipitator B Outlet Duct began at 10:26 a.m. Testing continued until the completion of the second test at 1:52 p.m. The first set of tests for mercury on Precipitator A began at 9:15 a.m. Testing continued until the completion of the second set of tests at 3:36 p.m. The samples were recovered. The equipment was secured for the night. All work was completed at 6:00 p.m.

On Thursday, October 21, work began at 7:00 a.m. The equipment was prepared for testing. The third test for flow rate on the Precipitator B Inlet Duct began at 7:17 a.m. and was completed at 7:47 a.m. The third test for flow rate on the Precipitator B Outlet Duct began at 8:26 a.m. and was completed at 8:56 a.m. The third set of tests for mercury on Precipitator A began at 8:00 a.m. and was completed at 10:35 a.m.

The samples were recovered. The equipment was moved off of the sampling locations and loaded into the sampling van. The samples and the data were transported to METCO Environmental's laboratory in Dallas, Texas, for analysis and evaluation.

Operations at the Tennessee Valley Authority, Widows Creek Fossil Plant, Unit Number 6 Precipitator A & B Inlet Ducts and Outlet Ducts, located in Stevenson, Alabama, for the Electric Power Research Institute, were completed at 12:30 p.m. on Thursday, October 21, 1999.

Billy J. Mullins, Jr.

Billy J. Mullins, Jr. P.E.
President

7 APPENDICES

A. Source Emissions Calculations

B. Field Data

C. Calibration Data

D. Analytical Data

E. Unit Operational Data

F. Chain of Custodies

G. Resumes